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Skill Biased Technological Change and Endogenous Benefits: The Dynamics of Unemployment and Wage Inequality*

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Abstract

In this paper, we study the effect of skill-biased technological change on unemployment and wage inequality in the presence of a link between social benefits and average income. In this case, an increase in the productivity of skilled workers and hence their wage leads to an increase in average income and hence in benefits. The increased fallback income, in turn, makes unskilled workers ask for higher wages. As higher wages are not justified by respective productivity increases, unemployment rises. More generally, we show that skill-biased technological change leads to increasing unemployment of the unskilled and to a moderately increasing wage inequality when benefits are endogenous.

The model provides a theoretical explanation for diverging dynamics in wage inequality and unemployment under different social benefits regimes: Analyzing the social legislation in 14 countries, we find that benefits are linked to the evolution of average income in Continental Europe but not in the U.S. and the UK. Given this institutional difference, our model predicts that skill-biased technological change leads to rising unemployment in Continental Europe and rising wage inequality in the U.S. and the UK.

Keywords: Unemployment, Skill-Biased Technological Change, Wage Inequality, Benefits

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1 Introduction

The well documented increase in wage inequality in the U.S. and the UK in the 1980s and early 1990s is attributed to an increase in the demand for skills that has been faster than the increase in skills supply. Predominantly so-called skill-biased technological change is blamed for the rapid increase in the demand of skills.[1] In most of Continental Europe, wage inequality increased much less if at all; instead it experienced a significant increase of unemployment, especially of the low-skilled.

Mainly, three arguments have emerged in the literature to explain the differences in the evolution of wage inequality. First, some authors argue that the supply of skills increased faster in Europe than in the U.S./UK (see Nickell and Layard (1999), and Leuven, Oosterbeek, and van Ophem (2003)). This approach is not able, however, to account for the differential evolution of unemployment. The second, and maybe most important, approach argues that collective bargaining and labor market institutions kept the wage structure compressed in Europe implying that skill-biased technological change has been leading to increasing unemployment.[2] The role of labor unions has obtained considerable attention (eg, Lindbeck and Snower (2001)). Labor market institutions as the unemployment insurance system and employment protection (eg, Mortensen and Pissarides (1999)), or minimum wages (eg, Teulings (2003)) have also obtained attention in the literature. The major theoretical drawback of the institutional approaches is that they mostly explain differences in the level of unemployment and the level of wage dispersion. Only few[3] can explain a widening gap of wage dispersion and unemployment as long as the institutions are unchanged.[4] Thirdly, and more recently, it has been argued that the demand for high-skilled increased less in Europe, because there, high wages for the low-skilled workers create an incentive for firms to invest in unskill-biased technologies, implying that technical progress is on average less skill-biased in Europe (see Acemoglu (2002)).

Our paper contributes to the view that it is the institutions that matter for the diverging evolution between the U.S./UK and Continental Europe. Our model is able to reproduce the differential dynamics of unemployment and wage inequality and not only levels. We argue that in Europe, skill-biased technological change has adverse effects on employment of unskilled workers because their wages are linked to the skilled workers' wages. This link is established by the indexation of social benefits to per-capita income.

Modern welfare states usually possess social protection systems including schemes that provide needy people with subsistence benefits. Often, the level of benefits is linked to the evolution of wages or per-capita income. The reason for this is that benefits are paid

[1] See, eg, Gottschalk and Smeeding (1997), Katz and Autor (1999), Acemoglu (2003), and Green, Felstead, and Gallie (2003). Other factors affecting the relative demand for skills that have been identified in the literature are organizational changes (eg, Lindbeck and Snower (1996) and Falk (2002)) and globalisation of goods and labor markets (see, eg, Fenstra and Hanson (1996), Baldwin and Cain (2000), Borjas, Freeman, and Katz (1996), and Tombazos (1999)).

[2] See, eg, Krugman (1995), Katz and Autor (1999), Blau and Kahn (1996), and Acemoglu (2002). Fewer authors argue that both, the stylized differences between the U.S. and Europe and the labor market rigidities used to explain these differences, are overstated in the above literature (see, eg, Nickell (1997), Gregg and Manning (1997) and Nickell, Nunziata, and Ochel (2005)).

[3] Krugman (1995) is such an exception. He uses the ad hoc assumption that—due to labor market institutions, the wage for unskilled labor is proportional to the wage for skilled labor.

[4] Admittedly, it has been noted in the literature that institutions have changed in reaction to shocks, such as skill-biased technical change. There has been a tendency towards deunionization in the U.S. and UK while, at least in the beginning of the 80s in Continental Europe employment protection was strengthened and benefits of the unemployment insurance have become more generous (see Blanchard (2006).)

to avoid poverty so that their level must be closely related to the "subsistence level". But the subsistence level is a relative concept and so is poverty.[5] Therefore benefits in general depend on the average wealth of a society. The strength of this link, however, varies across countries. We find that in most of Continental Europe the level of benefits is tied closely to per-capita income while in the Anglo-Saxon countries the benefits level has not been adjusted to per-capita income over the last 20 years. We show that this institutional difference is able to explain the transatlantic differences in wage and employment dynamics.

Endogeneity of the level of benefits with respect to the average income is important for labor market outcomes because it establishes a link from skilled workers' productivities to unskilled workers' wages: Changes in skilled workers productivities affect average income and thereby the level of benefits. This increase in the fallback income improves the bargaining position of the unskilled workers. In general this will result in higher wages and—for lack of respective productivity gains—higher unemployment.[6]

To demonstrate the mechanisms, our baseline model considers a "European" economy with skilled and unskilled labor. We assume that the market for skilled labor clears, while the market for unskilled labor does not. In the baseline model the wage for unskilled labor is determined by a monopolistic labor union while employment is determined by competitive firms.[7] Thus, the focus of this paper is on the (strikingly large) extent to which the unskilled workers' rate of unemployment exceeds that of the skilled workers. The fact that unemployment also exists among the skilled workers might indeed be explained by considerations of insider-outsider relations, search frictions, efficiency wages, or the like. These theories might be seen as complementary rather than contradictory to this paper.

The findings of the baseline model (and its generalizations) are consistent with the evolution of wages and employment of unskilled workers in Europe over the past decades. Wages for all skill levels have risen over this period and, by and large, the employment prospects of the less skilled workers have deteriorated.[8] In the United States (and the UK), it seems, that a shift in labor demand has led to an increase in wage inequality while in (Continental) Europe, where the wage structure has remained fairly stable, it resulted in a rise in unemployment, in particular among unskilled workers (see, eg, Siebert (1997)).[9] This coincidence of rising wage inequality in the United States and rising unemployment (at rather stable relative wages) in Europe suggests that the kind of feedback mechanism described in the our baseline model has been an important feature of labor markets in Continental Europe but not in the U.S. and the UK. We show that, on the basis of only

[5] See, eg, Foster (1998): "Absolute versus Relative Poverty" and the other contributions to the session on "What is Poverty and Who are the Poor?" in the AEA Papers and Proceedings Issue of the *American Economic Review* of May 1998.

[6] In fact, most benefit systems have unemployment insurance elements that depend on the level of past earnings rather than the general income level of the economy. Note, however, the following: First, unemployment insurance benefits are generally limited in duration. So, in the long run, it is social benefits that constitute the fallback income. Second, for unskilled workers, unemployment insurance benefits may easily fall short of the level of social benefits. In this case, the payment is increased to this level.

[7] Gürtzgen (forthcoming) shows that the impact of unions on wages is largest at the lower end of the skill distribution.

[8] See, eg, Siebert (1997), Katz and Autor (1999), or Acemoglu (2002). For Germany a detailed analysis of the employment and wage development from 1975 through 1990 is performed in Fitzenberger (1999).

[9] We are aware that the view that increasing unemployment in Continental Europe and increasing wage inequality in the U.S. and the UK are two sides of the same coin (namely skill-biased technological change) is not beyond controversy (see, eg, Nickell and Bell (1996), and Gregg and Manning (1997)). Yet, there seems to have emerged a large consensus among many economists that this view explains at least parts of the intercontinental differences (see, eg, Cahuc and Zylberberg (2004), Chapter 10.

one institutional difference, namely the link between benefits and per-capita income, we can explain this difference in employment and wage dynamics.

The remainder of the paper is organized as follows. Section 2 deals with the question whether and how tightly different countries link their benefit payments to the average income for a selection of OECD countries. The model is set up in Section 3. Comparative static results and the implications of our model with respect to the transatlantic differences in the social legislation are discussed. Section 4 summarizes and concludes.

2 Transatlantic Differences in the Social Legislation

In this section we analyze the legal situation both in Continental Europe and in the U.S. and the UK to demonstrate how benefits depend on per-capita income in different welfare systems. We find that in the United States and the UK benefits have not been adjusted to average income in the last 20 years, while in most European countries this adjustment is automatic and by law. Having observed this, in the next section our model shows that it is precisely this institutional difference that can account for diverging experiences in the evolution of wage inequality and unemployment.

We are aware that this binary classification into European and Anglo-Saxon countries is crude. There is substantial variation in the social legislation within these groups of countries.[10] But, when it comes to the evolution of benefits over time, the similarities within and the disparities between these two groups of countries are striking: In most European countries, these benefits depend on per-capita income by law, while this is not the case in Anglo-Saxon countries.

Let us consider the European countries first. In some countries, the adjustment of the benefits level over time is automatic by law, ie, there is a clear adjustment frequency and there are clear rules to what the benefits level is to be adapted. In other countries the legislation gives more scope to the government or the parliament to act and adjustments are discretionary. In some countries where there exist rules for the adjustment of benefits, the evolution of benefit payments is linked to the evolution of wages and/or income while in others, benefits are linked to consumer prices. Figure 1 in the appendix contains a synopsis of the social legislation in a selection of countries. In most European countries (Austria, Denmark, Finland, Germany, Italy, Netherlands, and Portugal), welfare benefits are automatically linked to the evolution of average wages, average income or public pensions (which on their part are linked to the evolution of average wages or average income) by law. Exceptions are Belgium, France, Greece and Spain. In Greece a general income support scheme does not exist. We discuss the remaining three countries in Appendix A.1 and provide empirical evidence that is in accordance with our main hypothesis.

In Anglo-Saxon countries, on the other hand, benefits are not linked to average wages or income. In the UK, "income support" is tied to the evolution of consumer prices only.[11] In the U.S., the institutional and legal situation is more complex.[12] Summarizing

[10] There have been several attempts in the European Union to harmonize social legislation - without much success, though. Two of the more successful attempts have led to the European Social Charter of 1989 and to the social protocol annexed to the Maastricht Treaty of 1992 - both not signed by the United Kingdom. If compared to other policy areas of the European Community, the treaties on social standards remain vague.

[11] There were no additional discretionary increases between 1979 and 2001 (see Cantillon, van Mechelen, Marx, and van den Bosch (2004)).

[12] For a concise overview, see Uccello and Gallagher (1997) from where most of the following information

the discussion from our working paper (see Weiss and Garloff (2005)), we can conclude, that none of the U.S. income support programs links benefits to the evolution of average income or wages. In fact, in many cases, amounts are not even adjusted for inflation.

Figure 1 in the appendix summarizes the institutional setting. It shows that welfare benefits are linked to average wages or income by law in most of Continental Europe but not in the U.S. and the UK. In Appendix A.1, we take a closer look at those European countries, that have no legal automatic link between benefits and wages or income and provide empirical evidence that is in accordance with our assumptions. The next section containing the baseline version of our model demonstrates that this institutional difference in the determination of benefits can account for diverging experiences in the evolution of employment and inequality.

3 The Model

3.1 The Baseline Case: Europe

Consider an economy with a continuum of mass 1 of homogeneous firms producing a single good. The good is produced using two input factors, unskilled and skilled labor. There is a continuum of mass 1 of workers of each type. Each worker supplies one unit of labor. For simplicity, the model is essentially static. There is no capital in the model so that consumption equals production at any point in time.

The firm produces according to the production function $Y = (a_u \cdot l_u)^\rho + (a_s \cdot l_s)^\rho\,, \quad 0 < \rho < 1, \quad 0 < a_u < a_s$ where Y is the quantity of the final good, l_u and l_s are the levels of employment of unskilled and skilled labor respectively, and ρ, a_u, and a_s are productivity parameters. This specification has the following properties. First, the elasticity of substitution between unskilled and skilled labor is $\sigma = 1/(1-\rho) > 1$. We restrict the analysis to substitution elasticities larger than one because only in this case does skill-biased technological change have adverse effects on the relative position of the unskilled workers. Furthermore, the majority of the empirical estimates are between 1 and 2 (see, eg, Autor, Katz, and Krueger (1998)). Second, the marginal productivities of unskilled and skilled workers are independent of each other and the cross wage elasticities of the factor demands are zero. We make this arguably strong assumption to guarantee that any relation between the wages for the two kinds of labor that arises in the model can be attributed solely to the institutional peculiarities.

These restrictions are also for simplicity. In Weiss and Garloff (2005), we consider the case of a more general CES (constant elasticity of substitution) technology. The results are shown to be independent of these different specifications.

Firms sell their products on the world market at the world market price $P = 1$ (by choice of the numéraire). At given wage levels, firms choose the level of employment so as to maximize their profits $\pi = Y - w_u \cdot l_u - w_s \cdot l_s$. The demand for unskilled and skilled labor is respectively

$$l_u^d(w_u) = \left(\frac{\rho \cdot a_u^\rho}{w_u}\right)^{\frac{1}{1-\rho}} \qquad \text{and} \qquad l_s^d(w_s) = \left(\frac{\rho \cdot a_s^\rho}{w_s}\right)^{\frac{1}{1-\rho}}\,, \tag{1}$$

where w_u and w_s are the wages for unskilled and skilled labor respectively.

is taken.

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The model involves unemployment of unskilled workers. All unemployed individuals are assumed to receive benefits, $\tilde{w}$. In accordance with the reasoning in the introduction, the benefits are assumed to depend on the net average income $\tilde{w} = \mu \cdot (1-t) \cdot \frac{Y}{2}$, where $Y/2$ is the per-capita income, t is the income tax rate, and $\mu \in [0,1]$ is a proportionality factor. The benefits are financed through a proportional income tax. The tax rate t is endogenously determined by the government's budget constraint $(1-l_u) \cdot \tilde{w} = t \cdot Y$.

All unskilled workers are assumed to be members of a labor union. The union chooses the wage to maximize the expected labor income of its members.

$$U = E\left[net\ labor\ income | w_u\right] = l_u\left(w_u\right) \cdot (1-t) \cdot w_u + \left[1 - l_u\left(w_u\right)\right] \cdot \tilde{w} \tag{2}$$

The first term in expression (2) represents the probability for any union member to become (or remain) employed (conditional on the wage level) times the net wage of employed unskilled workers. The second term represents the conditional probability to become unemployed times the alternative income (ie, benefits).

We assume that the market for skilled labor clears. This determines the wage for skilled labor $w_s = \rho \cdot a_s$. The wage for unskilled labor is assumed to be determined by a monopolistic labor union whereas the firm has the "right to manage". The union maximizes its objective function taking into account the effect of the wage level on employment. We assume that, out of idleness or lack of comprehension of the economic system, the union does not consider the second-round effects the wage has on the level of benefits and on the tax rate.[13] In the formal model, this means that the objective function (2) is maximized subject to (1) but taking the level of benefits $\tilde{w}$ and the tax rate t as exogenously given. Solving the maximization problem yields the following result which is familiar from the literature.[14]

Lemma 1 *Under the above assumptions, the wage for unskilled labor, w_u, is an increasing function of the level of benefits, $\tilde{w}$:*

$$w_u = \frac{\tilde{w}}{\rho \cdot (1-t)}. \tag{3}$$

In contrast to standard union models (and in contrast to what the union takes into account), in this model, the level of benefits is a function of the net average income which, in turn, is a function of the wage for unskilled labor. Accounting for this endogeneity in (3) yields[15]

$$w_u^* = \frac{1}{2} \cdot \frac{\mu}{\rho} \cdot \left[\left(\frac{\rho \cdot a_u}{w_u^*} \right)^{\frac{\rho}{1-\rho}} + a_s^{\rho} \right]. \tag{4}$$

The equilibrium wage for unskilled labor, w_u^*, is implicitly given by this equation.[16] It is easily verified that under the above assumptions, an equilibrium, $w_u^*\left(a_u, a_s, \mu, \rho\right)$, exists and is unique.[17]

[13] This assumption is also for simplicity. In Weiss and Garloff (2005), we consider the case where the union takes into full account the effects of the wage level on the level of benefits and the tax rate. The results are virtually unaffected.

[14] See, eg, Cahuc and Zylberberg (2004), Chapter 7.

[15] Equations (3) and (4) are two different ways of writing down the same result. In equation (3) the focus is on the dependency of the unskilled workers' wage on the level of (endogenous) benefits while in equation (4) the unskilled workers' wage is shown as a function of the exogenous parameters of the model.

[16] Throughout the paper, the term "equilibrium" will be used to refer to the allocation which results from union wage setting, given the other institutional features of the model.

[17] **Existence**: For w_u sufficiently small (resp. sufficiently large), the right hand side of the equilibrium

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3.2 Comparative Statics

The comparative static properties of the equilibrium allocation are presented in the following propositions:

Proposition 1 *An increase [respectively decrease] in the unskilled workers' productivity, as measured by the productivity parameter a_u, leads to an increase [respectively decrease] in both, the equilibrium wage and the level of employment of unskilled labor.*

$$\frac{\partial w_u^*}{\partial a_u} \cdot \frac{a_u}{w_u^*} = \frac{\eta_{Y,l_u}}{1-\rho+\eta_{Y,l_u}} > 0 \tag{5}$$

$$\frac{\partial l_u^*}{\partial a_u} \cdot \frac{a_u}{l_u^*} = \frac{\rho-\eta_{Y,l_u}}{1-\rho+\eta_{Y,l_u}} > 0 \tag{6}$$

where $\eta_{Y,l_i} = \frac{\partial Y}{\partial l_u} \cdot \frac{l_u}{Y}$.

A decrease in the unskilled workers' productivity leads—via a decrease in the average income—to a decrease in the unskilled workers' wage. But this decrease is less than would be required by the productivity loss because the wage is linked to the average income level which decreases by less than the unskilled workers productivity. Therefore unemployment of the unskilled increases. This failure of the wage to fully adjust to changes in productivity can be seen as a rigidity in the *relative* wage w_u/w_s.

While the wage for skilled labor always adjusts to clear the market, the wage for unskilled labor depends on the productivities of both, unskilled *and* skilled workers. In other words, the wage for unskilled labor is linked to the wage for skilled labor. The relative wage cannot fully adjust to changes in the relative productivity. This rigidity leads to an increase in unemployment in response to a decrease in the productivity for the unskilled workers. Similar results are obtained in standard union models where the reservation wage of the workers is exogenous.

Proposition 2 *An increase [respectively decrease] in the skilled workers' productivity, as measured by the productivity parameter a_s, leads to an increase [respectively decrease] in the wage for unskilled labor and a decrease [respectively increase] in the level of employment for unskilled workers.*

$$\frac{\partial w_u^*}{\partial a_s} \cdot \frac{a_s}{w_u^*} = \frac{(1-\rho)\cdot\eta_{Y,l_s}}{1-\rho+\eta_{Y,l_u}} > 0 \tag{7}$$

$$\frac{\partial l_u^*}{\partial a_s} \cdot \frac{a_s}{l_u^*} = -\frac{\eta_{Y,l_s}}{1-\rho+\eta_{Y,l_u}} < 0 \tag{8}$$

The increased productivity of the skilled workers leads to a rise in the average income. This in turn increases—through higher benefits—the unskilled workers' reservation wage and thereby their wage. Since the productivity of the unskilled workers remains unchanged, unemployment increases.

While the result in Proposition 1—that the wage *falls too little* in response to a fall in the productivity of the unskilled—is also obtained in standard union models, the result

condition (4) is larger (resp. smaller) than the left hand side. As both sides of the equation are continuous in w_u there must exist at least one value of w_u, w_u^*, for which both sides are equal. **Uniqueness**: The left hand side of (4) is strictly increasing in w_u whereas the right hand side is strictly decreasing in w_u. Therefore, if a solution to (4), w_u^*, exists, it must be unique.

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in Proposition 2—that the wage *increases too much* in response to a productivity gain of the *skilled* workers—is unique to this model where the feedback mechanism from income levels to wages is accounted for. In this model, the driving force behind *both* effects is the above mentioned rigidity in the *relative* wage.

Propositions 1 and 2 consider cases where only one type of labor becomes more productive. Depending on whose productivity increases, unemployment increases or decreases. Since in reality, technological change tends to affect the productivities of different types of labor at the same time, the question naturally arises which of the two opposite effects dominates. The following Proposition answers this question.

Proposition 3 *Technological change leads to a decrease [respectively increase] in employment of the unskilled and an increase [decrease] in wage inequality whenever it leads to an increase [decrease] in* $\frac{a_s}{a_u}$.

$$\frac{\partial l_u^*}{\partial \frac{a_s}{a_u}} \cdot \frac{\frac{a_s}{a_u}}{l_u^*} = -\frac{\eta_{Y,l_s}}{1-\rho+\eta_{Y,l_u}} < 0 \tag{9}$$

$$\frac{\partial (\frac{w_s}{w_u})^*}{\partial \frac{a_s}{a_u}} \cdot \frac{\frac{a_s}{a_u}}{(\frac{w_s}{w_u})^*} = \frac{\rho \cdot \left(\frac{\frac{w_s}{w_u}}{\frac{a_s}{a_u}}\right)^{\frac{\rho}{1-\rho}}}{1-\rho+\left(\frac{\frac{w_s}{w_u}}{\frac{a_s}{a_u}}\right)^{\frac{\rho}{1-\rho}}} > 0 \tag{10}$$

Skill-biased technological progress favoring the skilled workers' productivity in a way that leads to an increase in a_s/a_u has a negative effect on the *relative* demand for unskilled labor, l_u^d/l_s^d. Since the *relative* wage for unskilled labor, w_u/w_s, cannot fully adjust to this shift in labor demand, unemployment of unskilled workers increases.[18] On the other hand, if the productivity of unskilled workers grows faster [or falls more slowly] than the skilled workers' productivity, the wage for unskilled labor increases [respectively falls], but by less [respectively more] than would be justified by the shift in the relative productivity so that the employment of unskilled workers increases. Any technological change that leaves the ratio a_s/a_u unaffected has no effect on the level of employment.

This result is consistent with the view that it is the same factors that boost wage inequality in the U.S. and the UK and result in higher unemployment in Continental Europe. In a model in which the welfare system is less generous and wages are to a greater extent market-determined—the alleged features of U.S. and UK labor markets—skill-biased technological change (in the form of an increase in a_s/a_u) leads to a stronger increase in wage inequality while unemployment is affected less or not all. Appendix A.2 provides some descriptive evidence for this result.

Increasing trade with and outsourcing to low-wage countries have been cited as a second culprit of the rise in wage inequality in the United States.[19] In fact, in a two-sector version of this model, it can be shown that increasing trade with low-wage countries (as modeled by a decrease in the relative price of the import good—whose production is assumed to be intensive in the use of unskilled labor) has exactly the same effect on wages and employment as skill-biased technological change (as modeled by an increase in a_s/a_u).

[18] It is easily verified that $\frac{\partial (\frac{w_s}{w_u})^*}{\partial \frac{a_s}{a_u}} \cdot \frac{\frac{a_s}{a_u}}{(\frac{w_s}{w_u})^*} = \rho \cdot \left(\frac{\frac{w_s}{w_u}}{\frac{a_s}{a_u}}\right)^{\frac{\rho}{1-\rho}} \Big/ \left(1-\rho+\left(\frac{\frac{w_s}{w_u}}{\frac{a_s}{a_u}}\right)^{\frac{\rho}{1-\rho}}\right)$ is unambiguously smaller than ρ, the respective elasticity that prevailed if wages were perfectly flexible.

[19] See, eg, Fenstra and Hanson (1996), and Baldwin and Cain (2000).

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Increasing trade with low-wage countries also leads to a (downward) shift in the relative demand for unskilled labor. As the relative wage for unskilled labor does not fully adjust, unemployment of unskilled labor rises.[20]

3.3 Wage and Employment Dynamics: Anglo-Saxony vs. Continental Europe

In this section, we explore the implications of our model for the differences in wage and employment dynamics between Anglo-Saxon countries (AS) and Continental European countries (EU). For ease of presentation, we denote $\frac{a_s}{a_u} \equiv \alpha$ and $\frac{w_s}{w_u} \equiv \omega$ and normalize the productivity parameter of unskilled labor to 1. The technology is thus given by $Y = l_u^\rho + (\alpha \cdot l_s)^\rho$. Benefits are given by

$$\tilde{w} = \mu \cdot \left((1-t) \cdot \left(\frac{Y}{2} \right) \right)^\xi \tag{11}$$

where $\xi = 1$ in Europe and $\xi = 0$ in Anglo-Saxon countries. As expounded in Section 2, benefits are tied to the evolution of average income in Europe, but not in the U.S. and the UK.

In both regimes, the wages for unskilled and skilled labor are given by $w_u = \frac{\tilde{w}}{\rho \cdot (1-t)}$ and $w_s = \rho \cdot \alpha^\rho$. Taking into account the differences in the determination of benefits the relative wage for skilled labor is given by

$$\omega_{EU} = \frac{2}{\left(\frac{\omega_{EU}}{\alpha}\right)^{\frac{\rho}{1-\rho}} + 1} \cdot \frac{\rho^2}{\mu} \quad \text{and} \quad \omega_{AS} = \alpha^\rho \cdot \frac{\rho^2}{\mu} \tag{12}$$

in European and Anglo-Saxon countries respectively. The effect of skill-biased technological change on wage inequality is given by

$$\left(\frac{\partial \omega}{\partial \alpha} \cdot \frac{\alpha}{\omega} \right)_{EU} = \frac{\rho \cdot \left(\frac{\omega}{\alpha}\right)^{\frac{\rho}{1-\rho}}}{1 - \rho + \left(\frac{\omega}{\alpha}\right)^{\frac{\rho}{1-\rho}}} \quad \text{and} \quad \left(\frac{\partial \omega}{\partial \alpha} \cdot \frac{\alpha}{\omega} \right)_{AS} = \rho \tag{13}$$

It is easily shown that $\left(\frac{\partial \omega}{\partial \alpha} \cdot \frac{\alpha}{\omega}\right)_{EU} < \left(\frac{\partial \omega}{\partial \alpha} \cdot \frac{\alpha}{\omega}\right)_{AS}$ as long as $\rho < 1$. The effect of skill-biased technological change on wage inequality is smaller in European countries, where the linkage of benefits to the evolution of average income keeps the wage distribution compressed.

The effects of skill-biased technological change on unemployment in European countries have been discussed in Subsection 3.2. In the Anglo-Saxon regime, employment of unskilled workers is given by $l_u(w_u) = \left(\frac{\rho}{w_u}\right)^{\frac{1}{1-\rho}} = \left(\frac{\rho^2}{\mu}\right)^{\frac{1}{1-\rho}}$. Thus (un-)employment does not depend on the relative productivity parameter α. In summary, skill-biased technological change leads to an increase in unemployment in European countries and has no effect on unemployment in Anglo-Saxon countries:

$$\left(\frac{\partial l_u}{\partial \alpha} \cdot \frac{\alpha}{l_u} \right)_{EU} = -\frac{\eta_{Y,l_s}}{1 - \rho + \eta_{Y,l_u}} < 0 \quad \text{and} \quad \left(\frac{\partial l_u}{\partial \alpha} \cdot \frac{\alpha}{l_u} \right)_{AS} = 0 \tag{14}$$

[20] In several further extensions of the model, we assess the robustness of our results and show that the central results are kept. These robustness checks are performed with respect to the bargaining regime, the risk neutrality of workers, and the production technology. (Compare the working paper version of this article, Weiss and Garloff (2005))

We end this section by noting that a difference in bargaining power on the side of labor unions does not suffice to explain the differential unemployment and wage inequality dynamics between the two sets of countries in the presence of skill-biased technological change. If as in the model AS, the outside option does not react in response to an increasing demand for high-skilled labor, unemployment is unchanged irrespectively of the market power of labor unions. An explanation of the transatlantic difference that is linked to the bargaining power of labor unions requires a change in the bargaining power. In our model, it is the interaction of an increasing outside option and (an unchanged) bargaining power of the workers which cause the unemployment to increase. Of course, we do not negate the importance of the observed deunionization in the U.S. and UK and see our paper as complementary to studies that link the transatlantic differences to a change in bargaining power.

4 Summary and Conclusion

In this paper, we study the effects of skill-biased technological change on unemployment and wage inequality when benefits are linked to per-capita income. This link to per-capita income introduces a tie between the wages for different skill groups.

In standard models of union wage setting, wages—especially at the lower end of the wage distribution—depend on the level of unemployment or social security benefits (which constitute the workers' reservation wage). As a consequence, these wages are downwardly rigid. This rigidity causes unemployment when productivity falls. In our paper, benefits are endogenous and depend on wages. The interdependence between wages and benefits yields an allocation where the wage for unskilled labor depends positively on the wage for skilled labor. The obtained wage rigidity is a rigidity in the *relation* between the wages for unskilled and skilled labor. The wage for unskilled labor is *too rigid* with respect to the unskilled workers' productivity and it is *overly sensitive* to changes in the skilled workers' productivity.

If—as a result of skill-biased technological change—the productivity of the skilled workers rises faster than that of the unskilled workers, the wage of the latter increases by more than would be justified by their productivity gains because it is linked to the skilled workers' wage via the benefits. As a result, unemployment of unskilled labor increases. The matter of concern here is not that the unskilled workers' wage falls too little—as in standard union models—but that it *rises too much*.

The findings of this paper are consistent with the evolution of wages and employment of unskilled workers in Europe over the past decades. Wages for all skill levels have risen over this period and, by and large, the employment prospects of the less skilled workers have deteriorated.

Comparing the social legislation in the U.S. and many European countries, we find that benefits are linked to the evolution of average income or wages in Continental Europe but not in the U.S. and the UK. Given this institutional difference, our model predicts that skill-biased technological change leads to rising unemployment in Continental Europe and rising wage dispersion in the U.S. and the UK.

We can deduce interesting policy implications from the model. Any increase in the *relative* productivity (or more generally in the relative "market value") of skilled workers leads to a higher rate of unemployment the European model—even if the absolute produc-

tivity of unskilled workers increases as well, but less than proportionately. From the point of view of the model, we can blame two factors for the high unemployment of the unskilled. First, benefits are tied to the average income and second, benefits are a determinant of the wage of the unskilled. So, any policy measure that aims at weakening either of these links will decrease unemployment. It is to be noted, however, that our model does not challenge the principal insight from the literature that there is a tradeoff between wage inequality and unemployment. A decrease in unemployment would come at the cost of higher wage inequality. There might be possibilities, however, to overcome this dilemma. One way might be the introduction of a negative income tax. Such a tax scheme allows the uncoupling of gross from net wages. Gross wages (and thus wage costs for firms) are determined by market forces and reflect productivities and at the same time, inequality in net wages can be kept from growing. These wage subsidies to unskilled workers would have to be financed, but as these workers would not earn benefits anymore, the government's budget might even be relieved.

A Appendix: Empirical Evidence

A.1 The Link Between Benefits and Per-Capita Income

To confirm our main hypothesis, in Section 2 we look at the legislation of 14 countries (see Figure 1). In addition, here we use an empirical assessment to complement the results of the legal analysis. For 10 countries the legal situation is clear and confirms our crude classification in "European" and "Anglo-Saxon" countries. In three "European" countries Belgium, France, and Spain, benefits are not linked automatically to the average income or wages. Partly the law itself envisions that there are additional discrete adjustments. This is the case for example in Belgium. There, the law explicitly allows the king to adjust the benefit payments to the development of the living standards. As the legal situation allows these countries to be "European" and "Anglo-Saxon", we choose the empirical results to uncover the connection between average wages and benefit levels. For various reasons direct data on benefit levels are not available: In general, benefit payments depend on individual characteristics (wealth, income, household size, etc.) and differ across regions. Furthermore, in-kind transfers often make up an important part of total benefits. Therefore, we use data on (real) social expenditures on unemployment per unemployed from the OECD to approximate the benefit payments. We take the social expenditures on unemployment as a proxy for expenditures on benefits and take the number of unemployed individuals (from the OECD) as a proxy for the number of benefit recipients.[21] The last row of Figure 1 reports results from regressions of changes in real social expenditures on unemployment per unemployed on real GDP per capita changes.[22] The influence is significantly positive and roughly of the same magnitude for the three countries, where the legal situation is ambiguous.To assess the quality of our proxy social expenditures for unemployment per unemployed, we run the same regression for the other countries where we know the administrative rules. Most results are as we expect. In particular, the relation between GDP p.c. and social expenditures per unemployed is insignificant in the

[21] We use social expenditures on unemployment, since a category for benefits alone does not exist so that this category comes closest to our needs. Using in addition social expenditures on housing and incapacity-related benefits does not change the principal conclusions. Results are available upon request.

[22] It is likely that both real GDP per capita and real social expenditures per unemployed are trended. We use first differences in order not to run into the problem of a spurious regression.

Country	Austria	Belgium	Denmark	France	Finland	Germany	Greece
name of the programme	Sozialhilfe	Revenu d'intégration leefloon	Starthjaelp	Revenu minimum d'insertion	Toimeentulotuki	Sozialhilfe	none
adjustment frequency	automatic, yearly	automatic, yearly plus irregular	automatic, yearly	automatic, yearly	automatic, yearly	automatic, yearly	–
linkage to	public pensions	CPI plus discretionary increases	wages	CPI	public pensions	public pensions, wages	–
regression coefficient (standard error)	−1.518 (1.308)	0.955* (0.435)	2.965* (1.059)	1.265* (0.419)	1.045* (0.364)	1.132* (0.359)	– (–)

Country	Italy	Netherlands	Portugal	Spain	Sweden	UK	USA
name of the programme	Minimo Vitale, Reddito minimo	Algemene Bijstand	Rentimento social de inserçao	Ingreso minimo de inserciòn, Renta minima	Ekonomiskt bistånd	Income Support	various programmes, eg, Food Stamp Program, General Assistance
adjustment frequency	automatic, yearly	twice a year, automatic	automatic, yearly	semi-automatic, yearly	yearly	yearly	automatic, irregular
linkage to	wages GDP p.c.	wages	social pension	discretionary, CPI	standard ofliving	CPI	discretionary, CPI
regression coefficient (standard error)	−2.464* (0.489)	2.409 (1.951)	0.573 (0.545)	1.219* (0.592)	2.433* (1.062)	−0.366 (0.211)	−0.090 (0.419)

Figure 1: Social Security in "Anglo-Saxon" and in "European" Countries

Source: Cantillon, van Mechelen, Marx, and van den Bosch (2004) and MISSOC (Mutual Information System on Social Protection in the EU Member States and the EEA): http://europa.eu.int/comm/employment_social/social_protection/index_en.html and own calculation. * means significant on a 5% confidence level.

U.S. and the UK while it is significant in most European countries.[23] The purpose of these regressions is modest, however: We use the best information we could assemble. That is, we use the legal situation for the countries where the situation is unambiguous and use the regression results for the other countries, where the results are at least in accordance with our classification.

A minimum wage that depends on average wages has a similar effect as benefits that depend on average wages.[24] This is the case in France and Spain, where the minimum wage is tied to average income by law. So, for these two countries there is an additional link between the wage of the unskilled and the wage of high-skilled, even when, as in France, the benefits are not tied to the average income by law. A minimum wage that is tied to average income also induces adverse employment effects of skill-biased technological change. Again, for the U.S. and the UK this link does not exist. In the U.S., the minimum wage has not even been adjusted to consumer prices. In 2000 the minimum wage was 25% lower in real terms than in 1978 (see Card and DiNardo (2002), Figure 22). In the UK, a national minimum wage has only been introduced in 1999 and can therefore not account for changes in inequality and employment in the 1980s and 90s.

A.2 Descriptive Evidence to Proposition 3

Proposition 3 states that skill-biased technological change leads to rising wage inequality *and* rising unemployment in European countries because the relative wage cannot fully adjust to changes in relative labor demand. Put differently: If the wage dispersion in Europe rises, it does not rise enough and unemployment rises as well. The unemployment rate should thus be positively correlated with the skill-premium in Europe. For example, in Germany 1975 - 2004, the correlation between the unemployment rate of the unskilled and the skill premium has been 0.703.[25] This substantiates the theoretical result in Proposition 3.[26]

For the "Anglo-Saxon" model, we expect a zero correlation between wage dispersion and unemployment of the unskilled, since wages of the unskilled do not react to changes in the wages of the skilled. If the wage dispersion increases, it increases enough to adjust to changes in relative labor demand. Unemployment remains unchanged while wage dispersion increases. For the U.S. 1975 - 2003, the correlation between the unemployment rate of the unskilled and the skill premium has been 0.004.[27]

[23] Austria, Italy, the Netherlands, and Portugal are the exceptions to the rule.

[24] See Weiss and Garloff (2005).

[25] Unemployment rates by qualification are from Reinberg and Hummel (2005). The skill premium has been calculated from administrative data where the wage for unskilled workers is proxied by the lowest performance group of blue-collar workers ("Leistungsgruppe 3, Arbeiter") and the wage for skilled workers is proxied by the highest performance group of white-collar workers ("Leistungsgruppe 2, Angestellte"), Source: German Federal Statistical Office.

[26] The finding that higher wage dispersion and unemployment are positively correlated (across age-by-education cells) in Germany is also found and discussed by Fitzenberger and Garloff (forthcoming).

[27] Unemployment rates by educational attainment stem from U.S. Census Bureau (1975 - 2004) and Francesconi, Orszag, Phelps, and Zoega (1998). Wages stem from the CPS (U.S. Census Bureau, internet release, www.census.gov/hhes/www/income/histinc/incpertoc.html). Unemployment of the unskilled and wage dispersion are unlikely to contain a trend. While this is obvious for the unemployment rate at least in an asymptotic sense, it is plausible for wage dispersion, too. Nevertheless, we performed the same regression in first differences. Albeit less strongly, the results of a regression of the unemployment rate of the low-skilled on the wage premium in levels is significant for Germany (and insignificant for the United States).

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